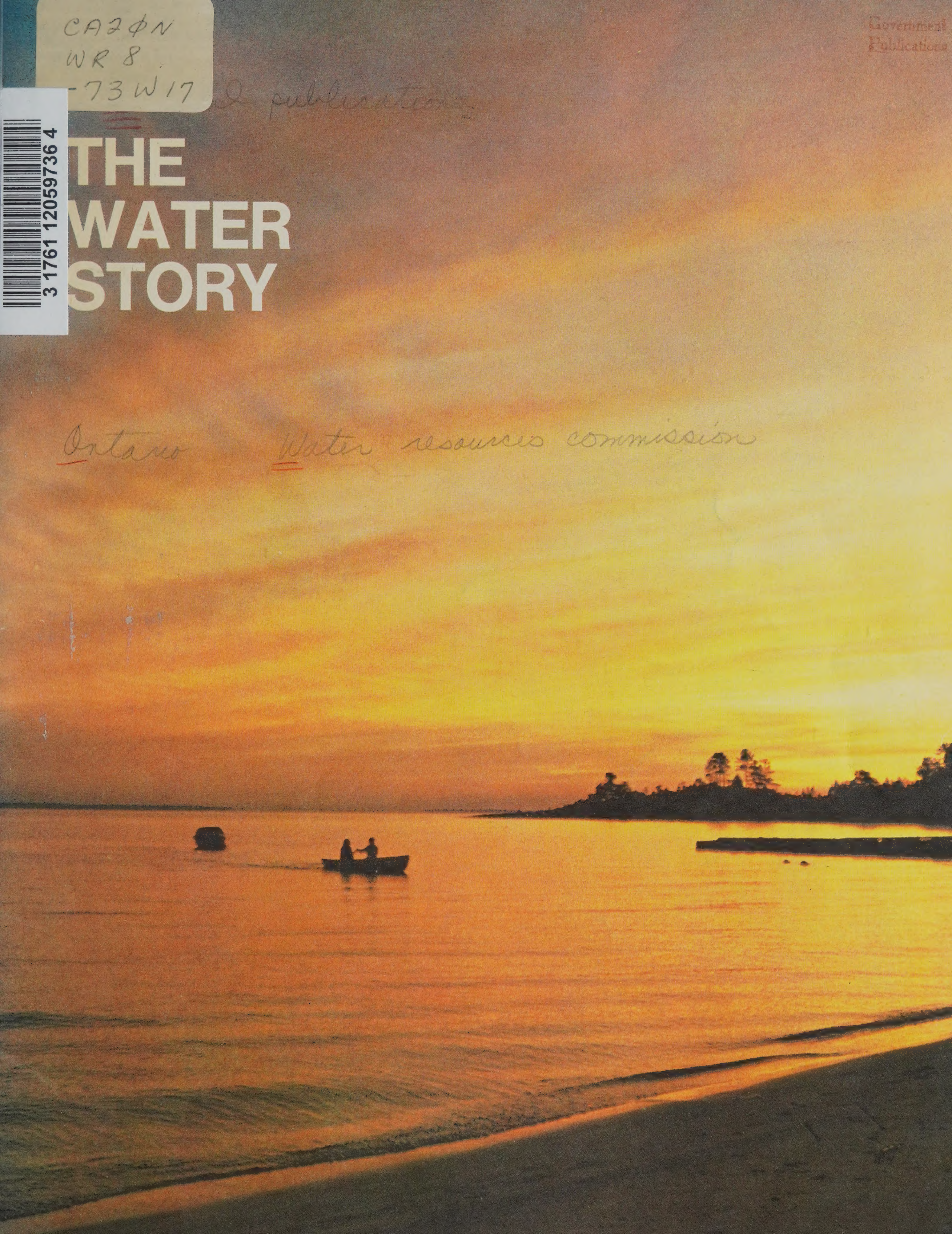
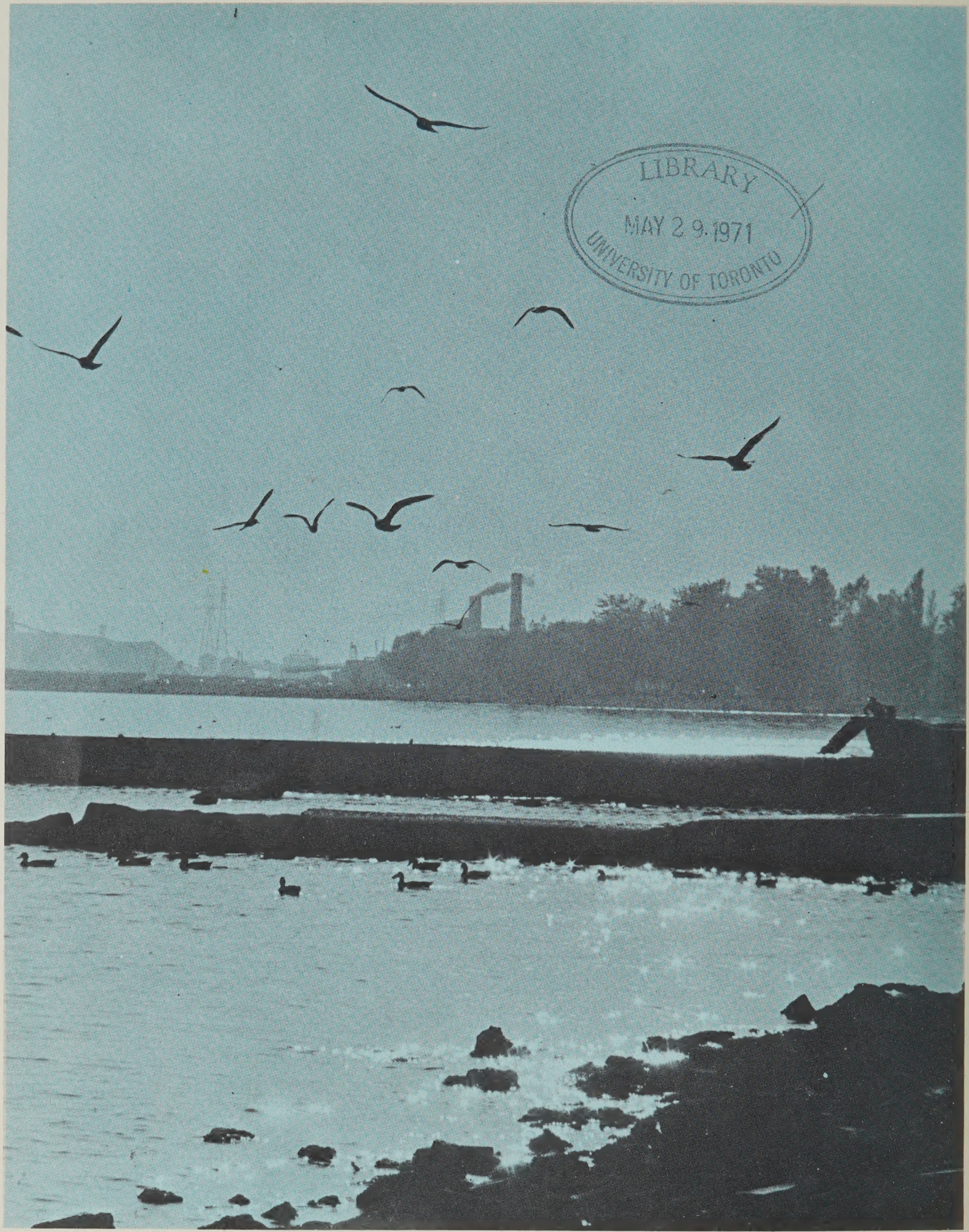
THE WATER STORY



Ontario Water resources commission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THE WATER STORY

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Water management in Ontario

Produced by the Ontario Water Resources Commission 135 St. Clair Ave., West, Toronto 7, Ontario.

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How pure is pure water?

Contrary to our familiar notions about water, its formula is not simple H_2O, nor is it a single substance. The purest water that can be obtained still contains, apart from hydrogen and oxygen, another substance, like hydrogen, but with an atomic weight of 2, or twice that of hydrogen.

Hydrogen contains one part of H_2 in about 5,000 parts of H_1. The properties of this heavy isotope (one or more forms of an element differing from each other in weight of atoms) of hydrogen are so different from ordinary hydrogen that the name 'deuterium' has been assigned to it with the symbol 'D'.

A third isotope of hydrogen, heavier than deuterium, called 'tritium' has also been discovered - H_3, having a mass of 3.017, and being radioactive.

Oxygen also has three isotopes: O_{16}, O_{17}, and O_{18}. The reference standard for chemical atomic weights is ordinary oxygen, taken as 16, which is really a mixture of isotopes with the distribution O_{16} = 99.758%, O_{17} = 0.0373%, and O_{18} = 0.2039%.

Thus the purest water that can be prepared in the laboratory is made up of six different isotopes (three of hydrogen and three of oxygen) which may be combined in 18 different ways. If we add the various kinds of ions (electrically charged particles into which atoms or molecules are dissociated) into which the addition or removal of an electron may transform the water's atoms, we find that pure water contains no fewer than 33 substances. The amounts of these special isotopes are, however, minute. H_2 is present to the extent of about 200 parts per million, and O_{18} about 1,000 parts per million.

Unusual waters

At many places in the world, and at many times in history, some waters have been thought to have specially-different properties. Some, even, have been called 'Miracle' waters.

One such 'Miracle' water is described in the Bible (John 5:2-9): "Now there is at Jerusalem by the sheep market, a pool, which is called in the Hebrew tongue Bethesda having five porches. In these lay a great multitude of important folk . . . waiting for the moving of the water. For an angel went down at certain season into the pool, and troubled the water . . . whosoever then first after the troubling of the water stepped in, was made whole of whatever disease he had."

The waters of the River Ganges in India are considered highly sacred and thousands of Hindus bathe in this river on various auspicious occasions. The Holy well at Mecca is also considered as highly sacred and pilgrims from all over the world bathe in, and drink the holy water.

Mineral spring waters may contain various dissolved minerals in medicinal doses. Alkaline waters containing calcium and magnesium-carbonates are good for digestive troubles and rheumatic complaints. There are many holy wells in the world that justify their medicinal fame by the fact that their waters contain Epsom salts, Glauber's salt, or sulphur compounds possessing a therapeutic action when applied internally.

Thermal springs are usually rich in mineral matter and usually have medicinal properties. High temperature may be due to volcanic action, but there must be other sources for hotsprings in regions where volcanic action has not recently occurred. These are chemical alterations of rocks which produce heat.

Where did all the water come from?

When our world was born, there was no water - only vapour.

It is now many hundreds of millions of years since the total quantity of water in, on, and around our world has varied by very much. Today, some 97.2% of the 326 million cubic miles of water our world contains is concentrated in the oceans - collected like rain puddles in the dips and hollows of the earth's crust. Of the remaining quantity, 0.017% lies on the surface as fresh-water lakes, saline lakes and inland seas, and as rivers and streams; 0.625% is subsurface water; 2.15% is trapped in the two icecaps and the glaciers of the world; and the remaining 0.001% is in the atmosphere.

New water, or water that is added to the earth's supply is called Juvenile water - and we get very little of it from year to year. There are five types of juvenile water, and a look at what they are will show how little we get:

Magmatic water - given up on crystallization of magma, molten rock at depth below the earth's crust.

Volcanic water - furnished by surface lava flow when oxygen and hydrogen units combine to form water.

Cosmic water - comes to us from space in the meteorites that enter our atmosphere.

Rejuvenated water - that returned to the terrestial supply by geological processes of compaction and metamorphism when water filling the pore space thus destroyed in rocks is forced into the aquifer.

Connate water - pockets of stagnant water (mostly saline) especially in structures holding gas or oil, which have not been flushed out with fresh water.

Water is constantly in motion: as liquid and as vapour. This give and take of perpetual exchange is called the hydrologic cycle and is described in detail on the next page.

About 95,000 cubic miles of water is evaporated into our atmosphere each year - with the greatest portion of this amount, some 80,000 cubic miles, rising from the oceans. Of this total of evaporated water, some 71,000 cubic miles falls directly back into the oceans, leaving some 9,000 cubic miles to rain down over the land and be returned to the sea within days or weeks. The remaining 15,000 cubic miles soaks into the soil and is available to the life processes.

Some of the water that soaks into the top layer of soil, however, becomes stored away in the folds of the earth. About one-million cubic miles of water is stored in this way - sometimes as great underground seas, sometimes as a fine network of water-filled tubes that thread their way between and around the less porous structures of our subsoil.

Unless a suitable lake or river is near enough to where we need water, it is this underground water body that we tap. By sinking a well into the water table (the level of underground below which the earth will be saturated) we are able to pump some of this huge supply to the surface.

Pumps are not always necessary, however, and, if the geological formation is right, quantities of water will be trapped under pressure between the folds of impervious material. A well sunk into such a formation might cause water to spurt many feet above the surface. Such wells are not uncommon and are called artesian wells.

The quantities of water we use today are fantastic by comparison with a few centuries ago. Man has always depended on water, and historians speculate that some of the world's now-dead civilizations may have perished either from a lack of water, or from their misuse of the available water. On page eight, we will see how water has been used throughout modern history, and also take a look at the quantities of water our present civilization is using.

The Hydrologic cycle

At all times the water is being exchanged between the surface of the earth and the atmosphere. This exchange is accomplished by the heat of the sun and the pull of gravity.

Wherever water is exposed to the atmosphere, the sun's energy causes it to evaporate and rise as a water vapour to form clouds. Moving with the air currents, the clouds collide and join together, or rise over a land mass until they cool when the vapour transforms into water droplets which fall as rain or snow.

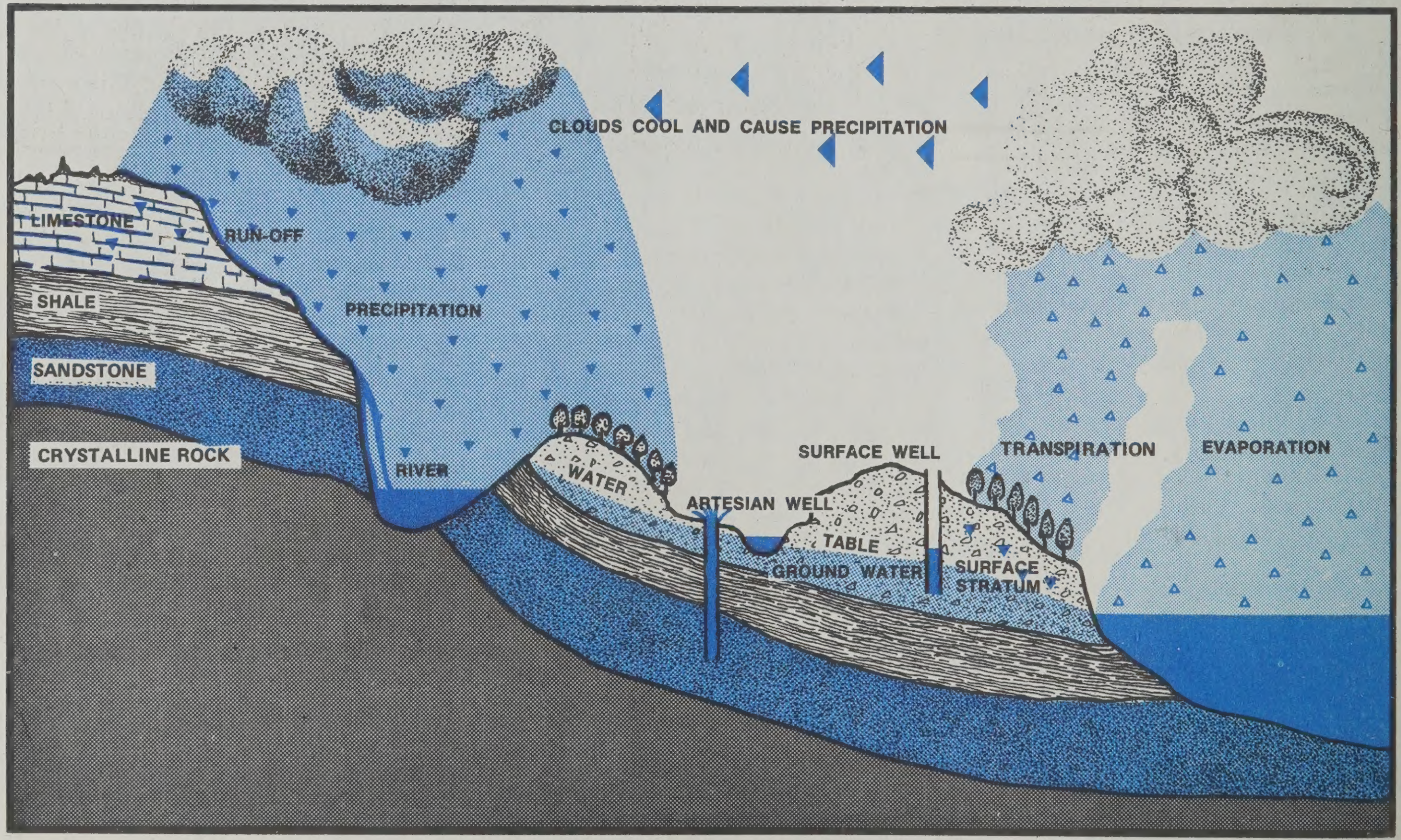
Three essential stages occur in this process: Evaporation - the turning of moisture into vapour; Transpiration the giving off of moisture by plants; and Precipitation - the return of moisture from the atmosphere. Let's look at each stage in a little more detail.

EVAPORATION: Although moisture will evaporate from any surface exposed to the atmosphere, the largest single source of evaporated moisture in the world is the huge area comprising the oceans. Acting like a vast heat engine, the sun warms the atmosphere which causes the moisture to change into a vapour. On the land, this same process takes place over all the rivers and lakes, and even over the soil itself where water is drawn to the surface of the earth and evaporated off. More water vapour is given off by plants and trees as they breath - but that process is a little different and is the second stage of the hydrologic process.

TRANSPIRATION: All plant forms give up moisture through their leaves. Trees, because of their huge size by comparison with other plant forms, evaporate tremendous amounts of water. In trees, water is taken from the soil by the roots, moves up the trunk as sap, and emerges from the plant through thousands of small holes on the underside of every leaf. It is estimated that an acre of apple trees may transpire as much as 600 tons of water in a season. On a hot day, a good-sized apple tree may lose as much as a gallon of water a minute.

PRECIPITATION: The amount of water vapour which the air can carry without loss by condensation depends on the air temperature. The higher the temperature the more vapour the air can carry. When moist air cools sufficiently, some vapour changes to liquid forming droplets which fall by gravity. Snow forms in a similar process, but the temperature is so low that the water freezes when the vapour condenses. The cooling of water vapour in the atmosphere comes about in two ways: when winds blow the clouds towards hills over which they are forced to climb into colder air; or when a mass of warm, moist air meets a mass of cold air.

Water that falls to the surface of the earth is either absorbed by the oceans, lakes and rivers, or soaks into the ground through the soil. Once in the ground, the water follows the layer of soil by flowing between the particles of soil or sand or gravel until it reaches a point where the strata becomes exposed by steeply falling hill sides. There it will emerge from the ground to form springs which feed the streams and rivers which eventually lead back to the sea. Once having emerged from the ground, the water is once again exposed to the warm atmosphere and begins to evaporate - thus completing the hydrologic cycle.



Water throughout history

Water dominates our history. Civilization became possible in all sections of the globe because of water - which transported discovery.

There are many references to water supply in the Bible. The ancient Chinese and Egyptians employed chemical coagulants to purify their water, probably the first form of water treatment. The Romans built huge aqueducts to transport water to their cities from outside sources.

In these early times, only the very wealthy could afford the luxury of water piped into their homes. The general public were provided with huge baths and public fountains.

In those days, and throughout the Middle Ages, the safety of a town often depended on its water supply. If an enemy sat around its walls, the beseiged people could hold out only as long as they had water. This was one reason for settling a town across a stream - then the water was safe inside the guarded walls.

The beginning of the Seventeenth Century brought the invention of pumps to lift water into the cities and reservoirs. The City of Paris installed a pump about this period to bring water from the Seine.

Reconstruction of water supply system typical in pioneer days.

Late in the same century a famous English astronomer, Halley, added up the amount of water flowing in the rivers to the Mediterranean Sea and found that the flow was about equal to the water falling as rain and snow in the area drained by the rivers. At nearly the same time, two Frenchmen, Perrault and Mariotte, made measurements of the flow in rivers and also found to about equal to the amount of water falling as rain or snow. These are the two earliest known instances of anyone having correctly reasoned that precipitation feeds lakes, rivers, and streams.

Throughout the late 1700's the use of water as a means of transportation within a country reached the height of its popularity in Europe, and saw many hundreds of miles of inland canals constructed. By 1830, canals in the British Isles totaled more than 3,000 miles. In America, too, canals were gaining in popularity and one, built between 1817 and 1825, stretched over 350 miles from Albany on the Hudson River, to Buffalo on Lake Erie.

Towards the end of that century, the importance of treating water - both before it was consumed by people, and after it had been used - was widely recognized, and the science of water treatment was born.

Today we know a great deal about water, both from the point of being able to manage its use and to control its quality, and, to a limited extent, to be able to control it as a resource within the framework of nature. Although we cannot as yet stop the rain from falling, under special circumstances, rain may be artificially induced to fall provided the atmospheric circumstances are suitable. Likewise, we can, by proper management and construction, control the effects of excess water forming in our river systems, and prevent excessive run-off of water from eroding the soil from our land.

Most of the history of man's development of his water resources has been written during the present century. As with most of the world's technologies, water resources management had a late start - but has advanced enormously of latter years.

The water we use

Modern living has increased man's use of water many fold. The average family today uses as much water in a day as did many families in a week several hundred years ago. The per capita consumption of water in Ontario is estimated to be 125 gallons per day - and rising. In some metropolitan areas, consumption tops 150 gallons per person per day.

The industrial thirst for water - no problem in the 19th Century - has become fantastic, and will continue to increase. Here is how much water is required to make a few of the items we are familiar with in our modern society:

One ton of paper - up to 65,000 gallons.

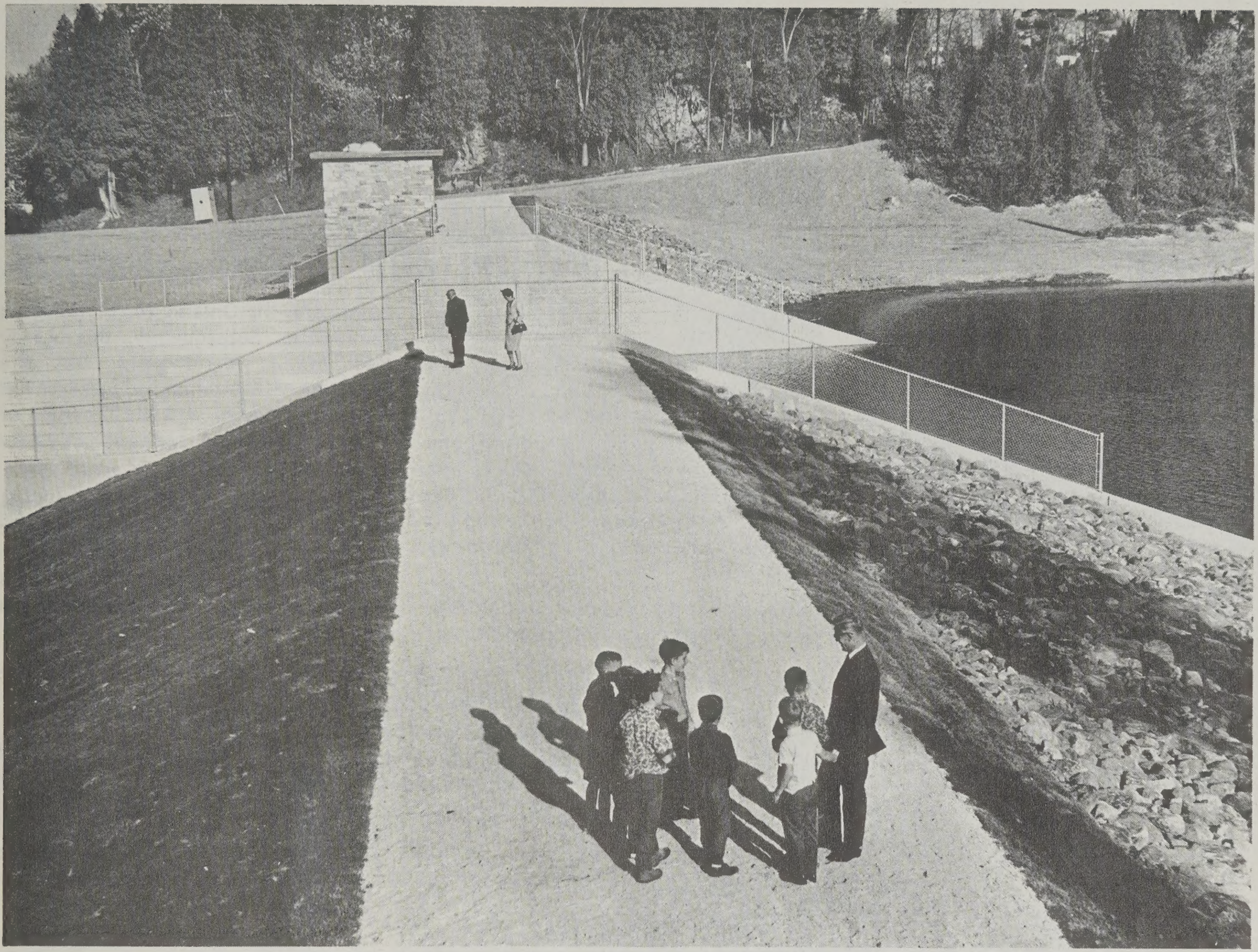
One ton of steel - up to 19,000 gallons.

To tan one hide - up to 450 gallons.

To process one barrel of crude oil - up to 700 gallons.

All human requirements are consuming more water: air conditioning, dishwashers, air pollution control, street cleaning, fire fighting, washing machines, and an almost endless list of others.

Apart from his physical comforts and conveniences, however, man requires water because man is, for the most part, composed of water - at least 65% to 70% of the body's tissue is water.



A controllable resource

Newly-constructed dam in conservation area. Control of waterway prevents damage during high stream flows, ensures flow at times of low rainfall, and creates recreation area.

In spite of the huge demands for water that our modern society and industrial community make; even though all water is constantly on the move and changing its state, it is a manageable resource and man has learned how to control it for his use.

Because of extreme local demands, water sometimes becomes in short supply to a community. This can come about through a variety of causes, only some of which are as a direct result of man's presence and activity. During years of low local rainfall, the ground water table may fall and less water be available in wells.

Upstream activity may reduce the flow in a river, or cause the level of a lake to drop. A sudden influx of people or industries to an area may make too heavy demands on a local water source.

Until relatively recently, such situations could be met in one of two ways - neither certain to succeed. In order to conserve water, both the citizens and the industries of a community could be rationed; or, alternatively, a search could be conducted for additional sources of water. But water is not always where you would wish it to be and a permanent water shortage, or water rationing are never satisfactory solutions.

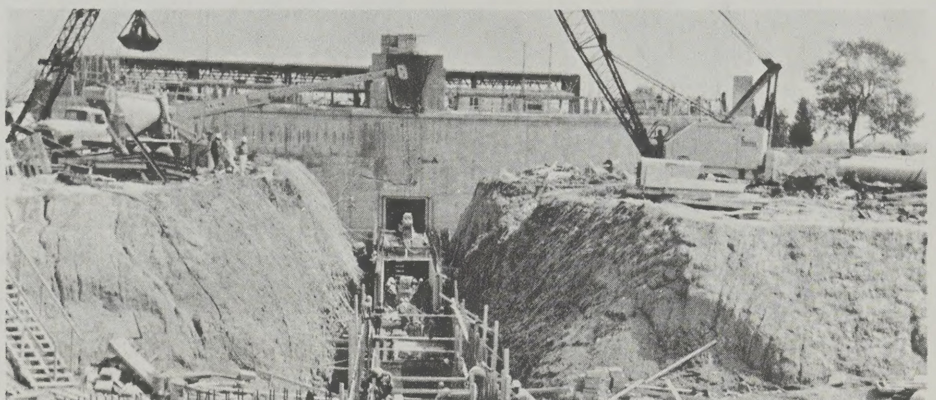
In Ontario, such situations are now being resolved with the help of the Ontario Water Resources Commission - the agency of the Provincial Government responsible for water management. Under a scheme of public financing, the OWRC is building large-diameter water pipelines to convey fresh water to water short communities. This, however, is only part of the OWRC's work, in addition, the Commission is responsible for the control of pollution of Ontario's waters.

The story of the Commission, and the work that it does, comes next.

The Ontario story

Water management in Ontario

Above: analytical work being conducted in one of the Commission's laboratories. Below: giant low-lift pumping station being constructed under the supervision of the Divisions of Construction and Plant Operations.



In Ontario, until quite recently, the Provincial Department of Health was responsible for public water supply and waste control - and much was achieved by them during the difficult years of population and industrial growth, The tremendous expansions in services and facilities that were required during the 1940's and 50's, however, presented the Province with problems that called for special action.

In response to this situation, in 1956, the Ontario Government created, by Act of Legislature, the Ontario Water Resources Commission. Subsequently, this agency was made responsible for the development, utilization and management of water resources, and the provision of adequate pollution control measures throughout the Province.

The Commission is organized into several Divisions, each of which has specific responsibilities and is staffed by trained and experienced experts in the field covered. Briefly, the Divisions are responsible for:

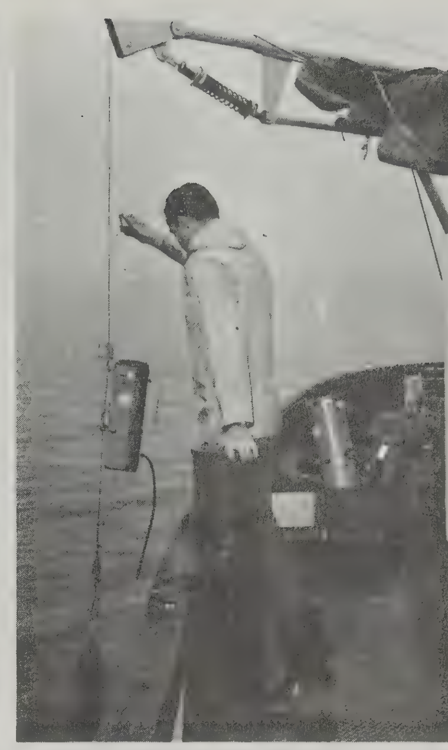
Divisions of Construction and Plant Operations - - construction and operation of water works and sewage works through agreements with municipalities.

Division of Project Development - organization and establishment of water supply and pollution control programs with interested municipalities.

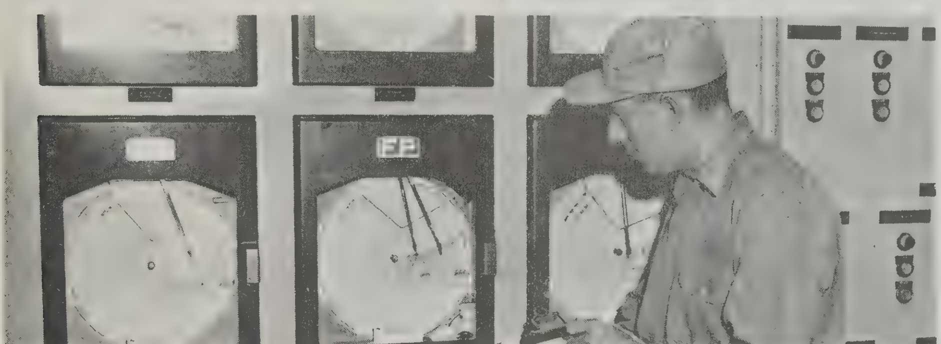
Divisions of Laboratories, Research, Sanitary Engineering, and Water Resources - - are charged with responsibilities covering a variety of water resources and water management problems.

Division of Industrial wastes - checks industry in the disposal of its polluting wastes and assists industry in helping solve difficult disposal problems. It co-operates closely with OWRC research experts in this work.

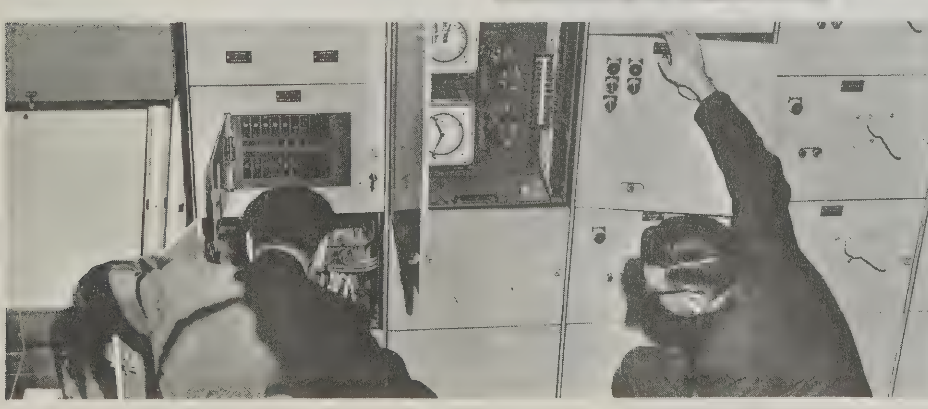
In water and sewage construction projects, the Commission has several procedures. It can enter into direct agreements with municipalities on an individual or area basis to arrange, on their behalf, financing, construction and operation of works on terms satisfactory to the municipalities involved. In such cases, the municipalities can take an active part in the operation of these projects through the appointment of local advisory committees. Commission supervisory personnel consult regularly with project staff and these local officials.



OWRC technicians from various divisions evaluate water bodies. At centre, a group of instruments are adjusted that measure a variety of factors on a small stream including flow, temperature, etc. Right, analytical samples are taken of lake water.



Above: plant operator records measurements of sewage treatment at an OWRC operated plant. Right: routine maintenance of plant equipment, in this case, a clarifier. Below: electronic equipment being installed at a treatment plant under supervision of OWRC personnel.



Another method is for the Commission to make use of Provincial Government funds to build such works for the use of municipalities, individually or in groups. Charges are related to actual use of the services provided.

Other items of the OWRC program include:

Operation of survey programs on an individual stream basis, or on county-wide or district basis to check the water quality, pollution control, and overall water resources.

Control through a permit system of water use from all sources.

A continual search for new ground water sources, and the licensing of the province's well drillers.

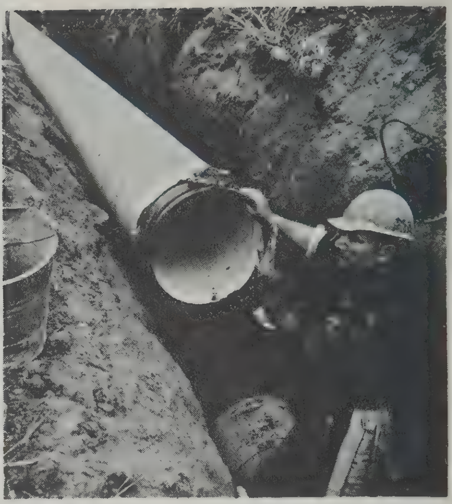
Co-operation with industry in seeking solutions to persistent and new waste treatment problems.

Control through a permit system of the use of chemicals to check growth of algae and other aquatic nuisances.

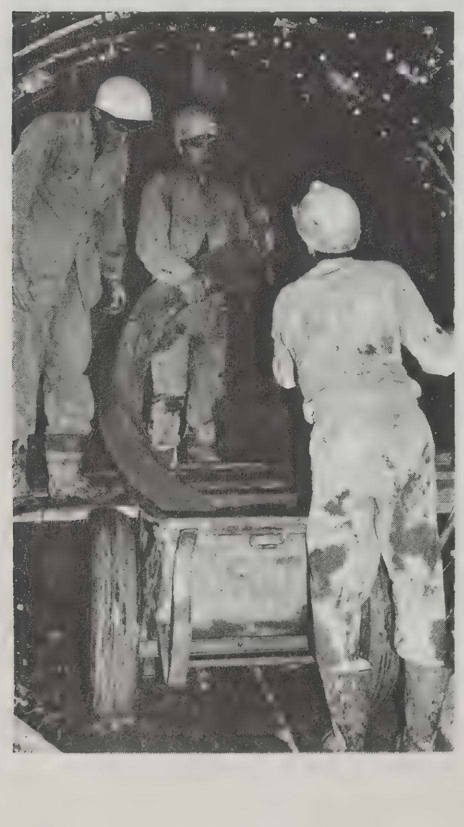
The review of plans for all water supply and pollution control projects to be undertaken by municipalities or persons. Such works cannot be undertaken without issuance of an OWRC Certificate of Approval.

Supervision of the operation of all water supply and water pollution control plants in the province.

To bring us our water



Three stages of laying a typical water supply pipeline: pipe is lifted into previously dug trench of correct width, depth and gradient; pipes are joined together with a gasket to form watertight joint; and a special metallic strap is bonded across each joint to ensure electrical continuity for cathodic protection. Below, miners tunnel through clay during construction of a major water supply main.



Surprisingly few people ever stop to think where the water comes from that flows from the taps in their houses. Most people, of course, realize that it is supplied to the property from a water main buried beneath the sidewalk or street. But from where do those watermains lead? And how does the water get to them?

Public water supply is a complex and exacting science. The degree of tolerance in the quality of the final product is very small - and on the maintenance of such high standards rests the health of the people such a system serves.

Good water - water fit to drink - is now hard to come by. In Ontario it is still possible to find streams and lakes that will supply such water, but they are not usually near the places in which we live. Wilderness lakes - those that have yet to experience the sometimes harsh effects of man's development - frequently contain water of unexcelled quality. Their remoteness and untouched natural beauty are not, however, any necessary guarantee of pure water, and the waters of some wilderness lakes would be totally unacceptable as a public supply as they may be tainted with decaying vegetable matter, coloured by dissolved mineral salts, or smelly from rotting plant growth that may choke tributary streams.

In the more populated parts of Ontario, almost all public water is treated in some fashion. Even the water drawn from wells penetrating deep into the sub-strata is frequently chlorinated to prevent any possiblility of bacterial contamination.

But we will learn more about chlorination a little later in our story. For now, we are concerned with getting a supply of fresh water into the pipes that connect to the houses, factories, schools and offices. To do this we must first take a look at the source of a municipal water supply, and then trace the steps by which the water is purified, sterilized, and finally pumped across the distance between the source and the furthest point to be supplied.

The water we drink

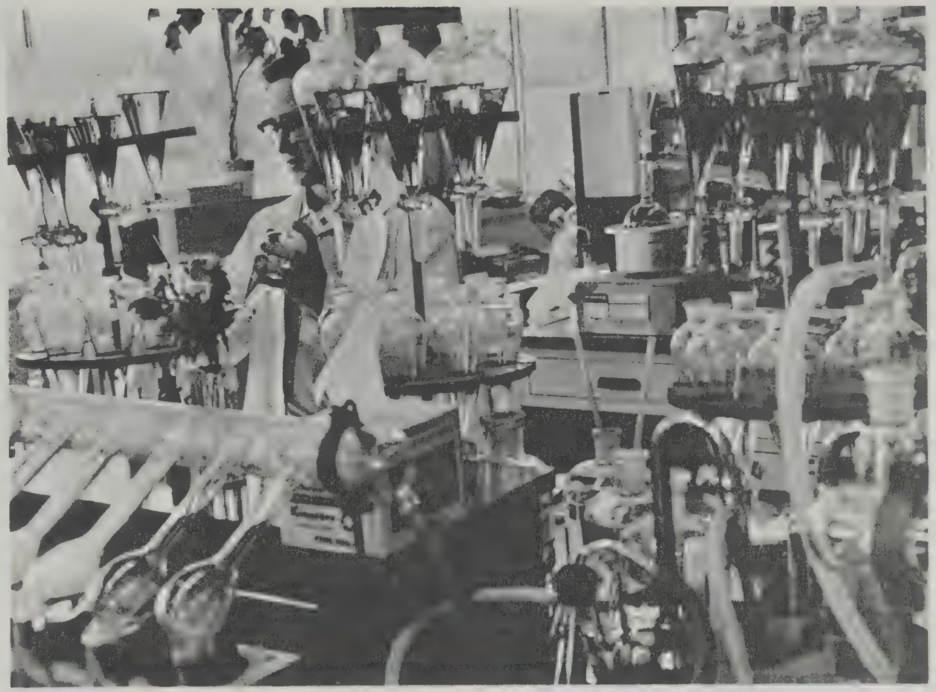
Each day, each one of us requires about two quarts of water in order to sustain our body functions. Some of this fluid we obtain in the food we eat, some in the variety of fluids we drink. The body has its own highly efficient water cleansing system that filters out many of the impurities naturally present in all except so-called chemically pure water. The capacity of this bodily machine is limited, however, and it cannot always protect us against disease-causing micro-organisms. Because of this, man usually has to treat or condition the water he drinks - and has evolved a 'standard' against which water may be measured before being certified 'fit to drink'. In Ontario, the drinking water quality objectives stipulate the following limits:

Alkyl Benzene Sulfonate (ABS)	0.5 mg/1 ▼
Arsenic (As)	0.01
Chloride (Cl)	250.0
Copper (Cu)	1.0
Carbon chloroform extract (CCE)	0.2
Cyanide (CN)	0.01
Fluoride (F)	*
Iron (Fe)	0.3
Manganese (Mn)	0.05
Nitrate (NO_3)	45.0
Phenols	0.001
Sulfate (SO_4)	250.0
Total dissolved solids	500.0
Zinc (Zn)	5.0

*When fluoride is naturally present in drinking water, the concentrations should not average more than 1.2 mg/l. Presence of fluoride in concentrations more than 2.4 mg/l shall constitute grounds for rejection of the supply.

When fluoridation (supplementation of fluoride in drinking water) is practised, the concentration recommended is 1 mg/l with a permissible operating range of 0.8 to 1.2 mg/l.

▼ mg/l = milligrams per litre.

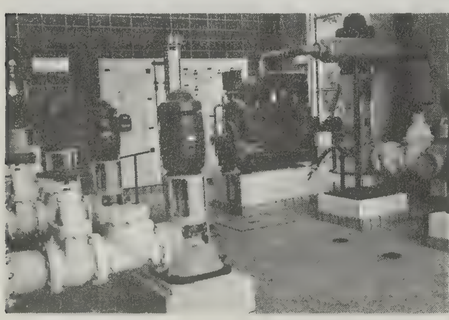


Chemical content of water

Symbol	Substance	Source	Effect
SiO_2	Silica	Clay minerals, opal, rock minerals.	Forms scale on boilers and steam turbines, inhibits pipe corrosion.
Fe	Iron	Igneous and sandstone rocks, iron pipes, pumps, storage tanks, etc.	Stains plumbing fixtures laundry and cooking utensils; spoils water taste and colour.
Mn	Manganese	Soils and sediments, metamorphic and sedimentary rock.	Has undesirable taste, leaves deposits on food during cooking, stains plumbing fixtures and laundry.
Ca	Calcium	Gypsum, calcite clay, limestone, rock minerals.	Combines with other minerals to form scale in boilers; inhibits formation of soap suds.
Mg	Magnesium	Limestone, clay, rock minerals.	Same effect as Calcium.
Na	Sodium	Clay, sediments, industrial wastes, rock minerals.	Produces scale and corrosion in boilers; combines with potassium carbonate to cause wood deterioration.
K	Potassium	Micas, clay, rock minerals.	Same effect as Sodium.
$HC0_3$	Bicarbonate	Limestone.	Combines with other minerals to form scale in pipes.
$C0_3$	Carbonate	Limestones.	Same effect as bicarbonate.
$S0_4$	Sulphate	Oxidation of sulphide ores, sulphate minerals, industrial wastes.	Forms scale, causes bitter taste, may be cathartic.
CL	Chloride	Sedimentary and igneous rocks, salty water forced upstream into tidal estuaries.	Has a salty taste, can be harmful to health.
F	Fluoride	Rock minerals, fluorite, mica.	Increases resistance to tooth decay but, in excess, may cause mottling of tooth enamel.
$N0_3$	Nitrate	Atmosphere, legumes, plant debris, animal excrement, nitrogenous, fertilizers, sewage.	Has a bitter taste, harmful in excess, especially to infants.
$CaC0_3$	Calcium Carbonate	Limestone.	Inhibits formation of soap suds, forms an insoluble scum or curd in washing machines.

The water is drawn

At top, a giant water intake structure is towed into position prior to being sunk and attached to the raw water intake. Centre: pumps that transmit water into a distribution system. Below: low-lift pumps drawing water from a river into a treatment plant. In background is gasoline-powered stand-by engine that cuts in during a power failure to ensure the supply of water to the community.

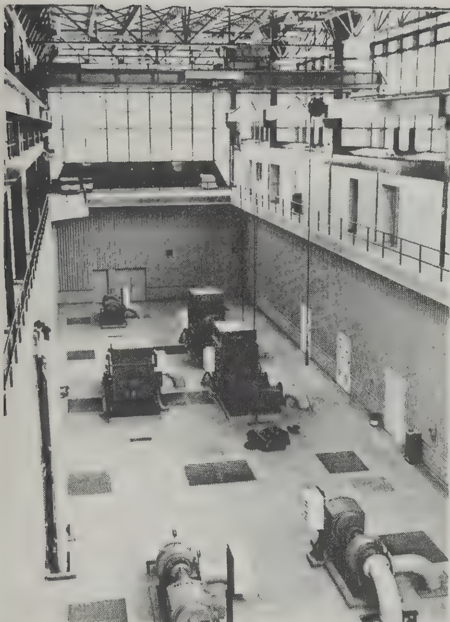


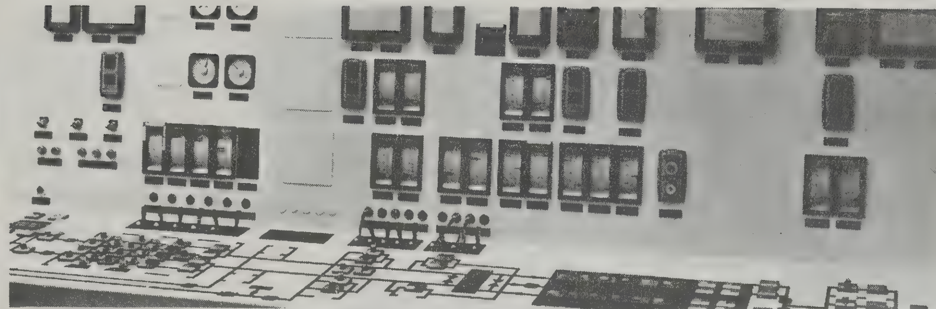
Practically all of Ontario's larger communities draw their water from a surface supply. This may be a river, or a lake; may be the equivalent of an inland sea, or a large stream that freezes over during the winter and has a high flow in the spring. Whatever the size of the body of water, the odds are that it will be contaminated with substances that will give it a colour, taste, odour, or cloudiness, that will require treatment for removal before the water can be used. As well, it may contain traces of a sewage discharge and therefore be unsafe as a drinking water in its raw state.

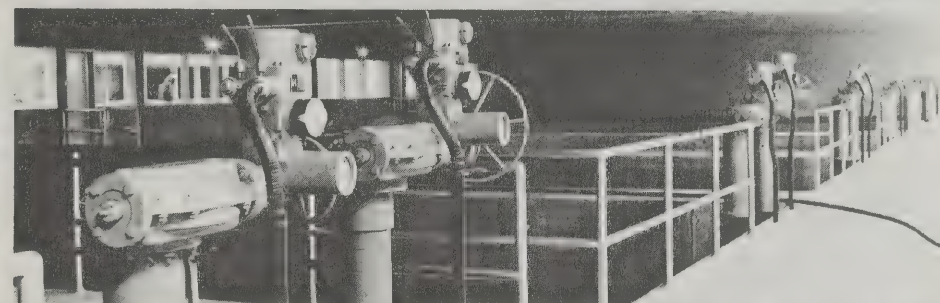
The first stage in converting this water is to draw it to a place where it can be treated as necessary. Just placing a pipe into the water will almost certainly not be sufficient to achieve this and the intake structure is frequently a complex piece of engineering. Not only must the end of the pipe be protected with a structure to prevent large pieces of wood, ice, and even tree trunks from being sucked into it, the position in which the pipe is placed must be carefully chosen. Shallow water above the structure might cause it to be damaged by ice; the wrong choice of position may cause bottom silt to be sucked in with the water; an error in estimating the currents and flows may leave the intake in a backwater where, in winter, ice may form right to the bottom.

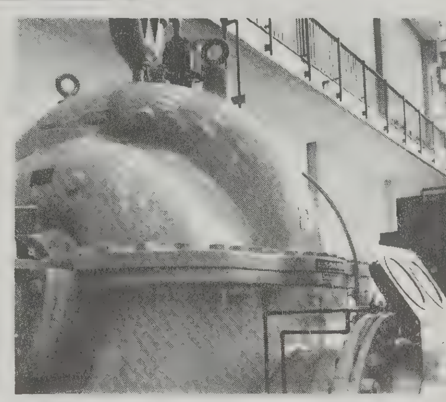
Water is drawn through the intake by pumps housed in a low-lift pumping station. The term 'low-lift' is used because, apart from drawing the water through the pipe, the pumps only have to lift the supply to the height of the treatment plant - frequently a distance of only a few dozen feet.

Before being lifted by the pumps, however, the raw water is first passed through a bar screen where reasonably-large sticks, fish and other solid matter are strained out.









Typical water treatment equipment. Clockwise: pumproom, control panel, flocculation tanks, high-lift pump, filter beds.

From raw to treated water

Having been lifted to the treatment plant, the raw water now passes through a variety of processes. Depending on the condition of the water - which may vary from season to season throughout the year - it may require to be passed through a microstrainer (a large rotary drum covered with a cloth or steel mesh of micron-size openings for the removal of algae or large-size impurities). Likewise, if the water contains too much turbidity - the finely-divided suspended and colloidal material in suspension - it may require the addition of such chemicals as lime, alum, ferric sulphate or others to cause the particles to adhere to each other and thus settle. The addition of chemicals and the process of settling are carried out in separate tanks and is called flocculation.

Even if both these stages are passed through, the water may still contain some turbidity or other foreign matter. In this case, the partially-treated water would be passed through a filter.

Water filters, generally, are classified as either gravity or pressure flow. Both achieve the same effect - the removal of extremly fine matter from the water.

Both use a combination of materials such as sand, gravel, anthracite, or fine-crushed stone in layers. The water is passed through the layers at a carefully controlled rate and the suspended matter is trapped in the increasingly-smaller voids between the materials. Having been filtered, the water is collected and stored in a large tank, called a clear well, ready to be pumped into the distribution system serving the community.

Naturally, the more material the filters trap, the quicker the layers making up the filter bed will become clogged. When that happens, a series of valves are adjusted and a quantity of already filtered water is pumped back from the clear well, and forced backwards through the filter - flushing out all the trapped debris which is discharged to a sewer. Once the filter is cleaned, the valves are re-adjusted and the filter goes back into operation.

How water is brought to your house

Rivers run through valleys; lakes lie in bottom land; houses are built on the ground above the water. If, then, the water has been drawn from its source and prepared for domestic use, it must be somehow forced up the slopes to where it is needed. Somehow, having been carefully treated and made pure, it must be sent through the transmission mains that thread their way throughout the community.

A carefully engineered network of distribution pipes lies buried beneath the roads and streets of most municipalities.

Like the arteries and veins that carry blood through the body, the water mains that leave the treatment plant are the largest of the system, and branch off wherever necessary into smaller, and smaller, and yet smaller pipes at the extreme limits of the system. Stubbing off from these mains, wherever a service connection is required, pipes - often no thicker than your thumb - carry the essential water to the properties concerned.

Forcing the water through these miles of pipes, always maintaining a constant positive pressure, are a battery of pumps in the high-lift pumping station.

Sometimes more than one station is needed along the way to boost the water up a greater height of land.

So that the pressure of water available at the taps of a community might be uniformly equal, most systems have reservoirs or elevated storage tanks on heights of land to which the water is first pumped. A return pipe system then services the dwellings. By the time the tap in your house is turned on, the water you receive will have travelled a long way and have passed through many stages of treatment and supply. Because of the work done by the OWRC and the water authority in your community, that water will be safe for you to do with as you will.

When you have used the water, however, you then let it drain away. By pulling the plug in a sink, or by flushing a toilet, you let the now dirty water swirl around and disappear from view. Where does it go?

Where the dirty water goes to, and what has to be done to it before it can be discharged to a river or lake is the next part of our story.

To make our water safe

Just taking the apparent impurities out of a raw water is not enough, though. There is always the chance that the source of the raw water may have become contaminated with sewage wastes - and there are few water sources in southern Ontario, for instance, that do not contain a trace of such contamination.

As well, this sewage may originate from a system collecting the wastes from either a homestead, or collection of homes in a municipality, or from a farm discharging animal wastes. In either case, the chances are that harmful bacteria may be present in the water - pathogenic organisms that transmit disease between mammals.

To safeguard our water, the OWRC requires all such surface supplies to be chlorinated. In some treatment plants, chlorine is applied before treatment as well as after in order to prevent a possible build-up of micro-organisms at any point within the plant. The main point of application, however, is as the water leaves the filters, and sufficient chlorine is injected so that, after neutralizing any harmful bacteria present in the water, a residual will be left. In this way, assurance is always there that sufficient chlorine has been added and that the water is safe.

The chemistry of water disinfection

Chlorine (Cl_2) is produced, chiefly, by electrolysis from sodium chloride ($NaCl$), or common salt. It is supplied commercially as a liquified gas under pressure, and vaporizes at -30°F. When it becomes gas, chlorine acquires a greenish-yellow colour and a very pungent odour.

When chlorine is added to water, the following reaction takes place: $Cl_2 + H_2O = HOCl + HCl$ or Chlorine plus water produces hypochlorous acid plus hydrochloric acid.

The hydrochloric acid is neutralized by carbonates which are naturally present in water. The hypochlorous acid is a powerful disinfectant. Part of it is quickly used up in killing the bacteria in the water. The remainder stays in the water as a residual - a sort of safety margin - which keeps the water bacteria-free until it reaches its point of use.

This residual can take two forms - either a combined or a free residual. In the combined form, the hypochlorous acid combines with ammonia (which is present in most waters) taking a relatively long time to kill bacteria, but remaining very stable. Thus, for a large water system, it is desirable to keep a combined residual in the system to assure safety from the treatment plant to the farthest point of supply.

By adding more chlorine and producing hypochlorous acid, the ammonia may be overcome. The hypochlorous acid remaining becomes a free residual which, although not as stable, has a shorter bacterial killing time than a combined residual.

Maintaining an adequate residual is the only way of ensuring that water is safe. Its presence proves that enough chlorine was added to fully disinfect the water.

When water becomes a waste

Once water has been used, it rarely becomes anything but a waste to be disposed of. In less enlightened times, the methods of this disposal often left much to be desired - at one time it was the custom to simply empty the slops into an open gutter running down the centre of most town and city streets.

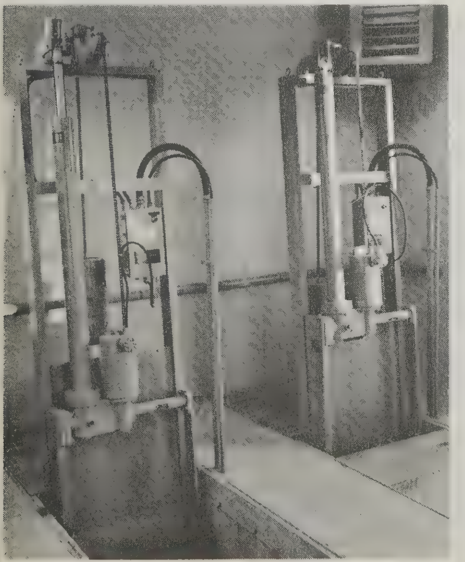
For many years now, legislators have heeded the warnings of sanitary engineers and prohibited the uncontrolled discharge of untreated liquid wastes. Although it is still not necessary for every home to be connected to a municipal sewerage system, individual properties and farms may be built and equipped with septic tanks, no one is permitted to dispose of untreated sewage by just letting it run away.

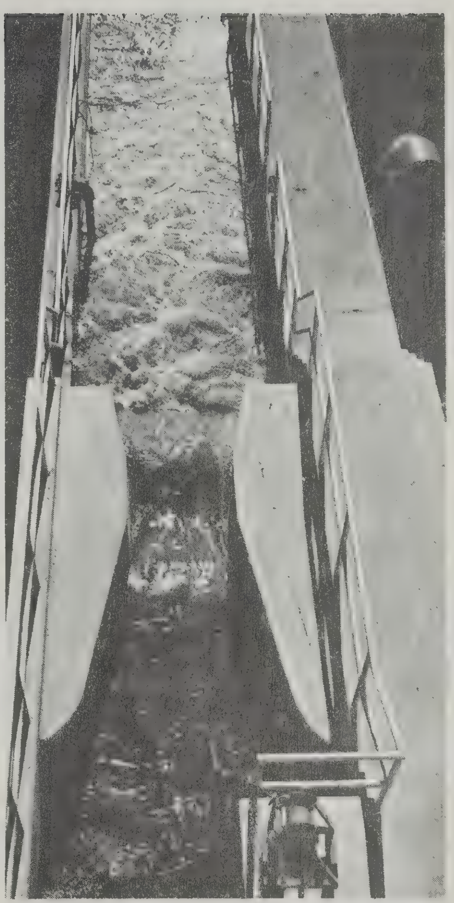
For the majority of those living in Ontario, the system of pipes that brings water to their homes is paralleled by another system to take the wastes away. Equally complex in their design, these pipes often run at great depths below the surface - for the liquid wastes flow through them by gravity and a carefully-designed gradient ensures that they flow continuously, and cleanse the pipe as they pass.

Generally, such pipe systems lead to an area of low-lying ground within the municipality, adjacent to a river or stream that can be used as a final receptical for the fluids. Again, time was when the last pipe of the system would simply protrude into the river and the raw wastes would mingle with the flowing stream. Prompted by the OWRC, practically all of the province's communities now have a system of treatment interspersed between the collection system and the point of discharge. The degree of treatment given the waste varies according to the location of the community, and the nature of the wastes, and may generally be considered to fall into one of three orders of waste treatment - each more comprehensive than the other.

The three gradations are: primary, secondary, and tertiary treatment. In general terms, primary treatment is mechanical treatment, the physical separation of one element from another. Secondary treatment relies on a biological system where carefully cultivated and nurtured micro-organisms help purify the wastes, and tertiary treatment is a chemical and/or physical stage for the fine-polishing of an effluent.

Equipment for the comminution of raw wastes (in this case a 'barminutor') at the entry works of a sewage treatment plant.





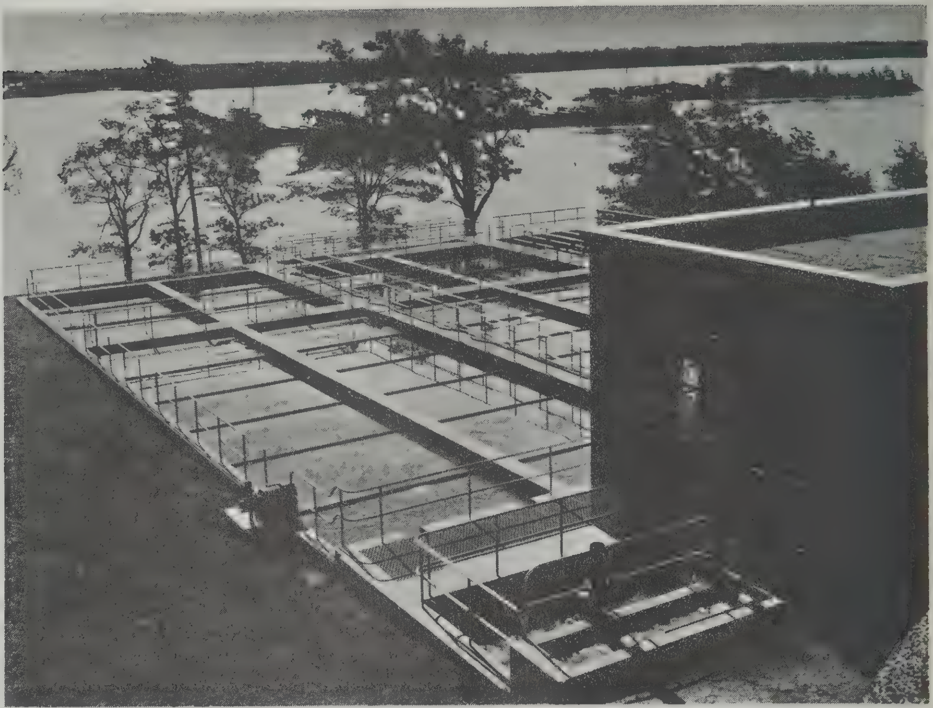
Parshall flume - an engineered restriction in a flow channel - by which the total volume of wastes being processed by a sewage treatment plant is measured.

Primary treatment - first stage treatment - is the basic stage in sewage purification. Once the wastes have been collected and piped to a specific location, treatment can begin. Before describing what this involves, let us consider for a moment, the nature of the material to be processed.

Domestic wastes - those wastes eminating from a domestic environment - are 99% water. Much of this water will be hardly contaminated as it enters the sewers; it will come from rinse water as various articles are flushed clean, it will come from the lightly polluted waters that discharge from baths and wash basins, and some will enter the pipes from the ground as infiltration.

The solid fraction of the wastes is the most dangerous portion and mostly consists of the solid wastes we excrete from our bodies as a natural physiological function. As well, solid particles washed into the sewer system from kitchens and workshops add to the pollution load.

When water becomes a waste (continued)



Rectangular primary clarifier tanks with, in foreground, grit removal chamber.

Combined, this volume of waste water just about equals the amount of fresh water consumed by each person in the community - about 100 gallons per capita per day.

The stage of primary treatment that these wastes go through is simply to separate the solids from the liquid. The process is conducted under controlled conditions in large, mechanically equipped tanks, and the degree of efficiency of the process can be predicted and adjusted to very fine limits.

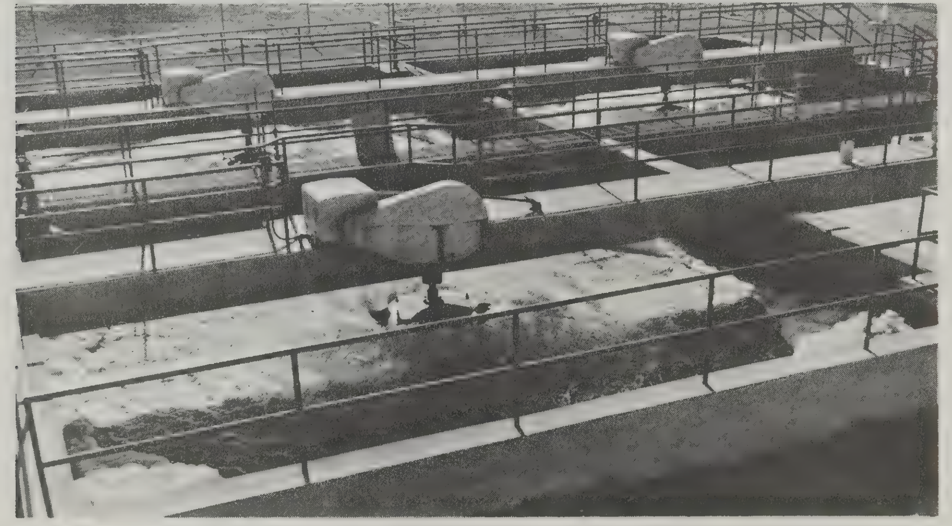
The first step is to screen out the larger items of material. Then, the wastes are passed to a large tank where they are detained for a specific period.

During this time, the solid fraction of the sewage settles to the bottom and is removed to another tank by a mechanical system of scrapers. The liquid portion is then passed through a chlorination tank and discharged to the receiving stream.

The collected sludge is further treated in a closed tank, called a digester, before being disposed of.

To summarize: primary treatment removes the heavier particles, scum and grease from a waste water. The effluent produced is of a lower standard than is achieved in secondary treatment and the amount of solids removed ranges from 40 to 60%.

Aeration tanks with, in this case, mechanical aerators. Air is introduced to promote growth of micro-organisms that oxidize fraction of waste.



If the treatment facilities include a secondary stage, then the liquid from the primary settling tank is conducted to another series of tanks where a biological reduction of the remaining wastes takes place.

Most secondary treatment plants in Ontario employ the 'activated sludge' method. In this, a suitable culture of micro-organisms is maintained in an aeration tank where they are supplied with oxygen. As the organic impurities are assimilated (oxidized) by the micro-organisms, the resulting sludge formation is dense and flocculant and can be settled easily to provide the bacteria with a growth environment.

Final settling tanks provide the means for removing and reclaiming this sludge floc which is pumped back to the aeration tanks as activated sludge (a term referring to the biological communities it contains).

To summarize: secondary treatment further reduces the pollution load within the waste by providing a suitable environment for the biological oxidation of the finely suspended matter. It is capable of a high degree of sewage purification and can result in from 90 to 95% reduction of solids.

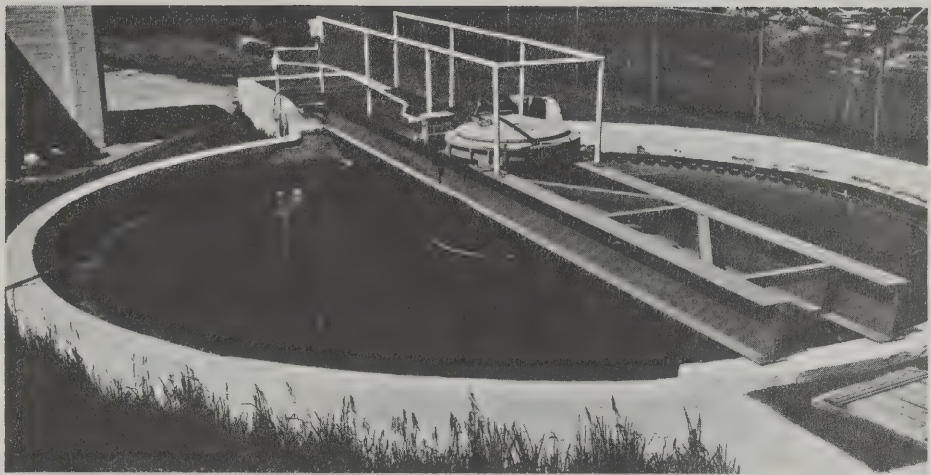
Tertiary treatment is a relative newcomer to the science of water management and

only a few such facilities have, as yet, been built. In essence, the effluent from a secondary treatment facility is further conditioned to finally remove the particular matter remaining in the liquid portion. There are several mechanical systems by which this can be achieved - some of which closely resemble the filtration stage described when discussing water treatment.

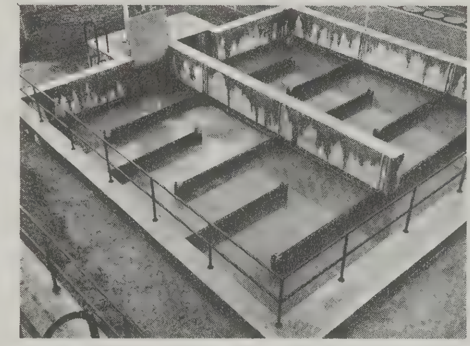
Although but one system approach has been described, many variations exist and have been selected to suit the conditions prevailing at the point of application. Such treatment methods as oxidation ditches, aerated lagoons, step-aeration, activated sludge, trickling filters, total oxidation, and many others have their examples in many Ontario communities.

Through a comprehensive program of sampling and testing, the OWRC is constantly aware of the performance standards of waste treatment plants throughout the province. Where, in spite of sewage treatment by the local communities, the quality of a watercourse continues to decline, the Commission is instrumental in requesting, and obtaining, a higher standard of waste treatment. The quality of the receiving stream is the final criterion by which waste treatment effectiveness is judged. The water in that stream is the commodity that is so precious to life, to health, and to welfare.

Domestic pollution from our municipalities is not the only source of pollution, however. Other segments of our society also produce wastes and the OWRC has responsibilities that cover them. That will be the last chapter of our story - industrial pollution control.



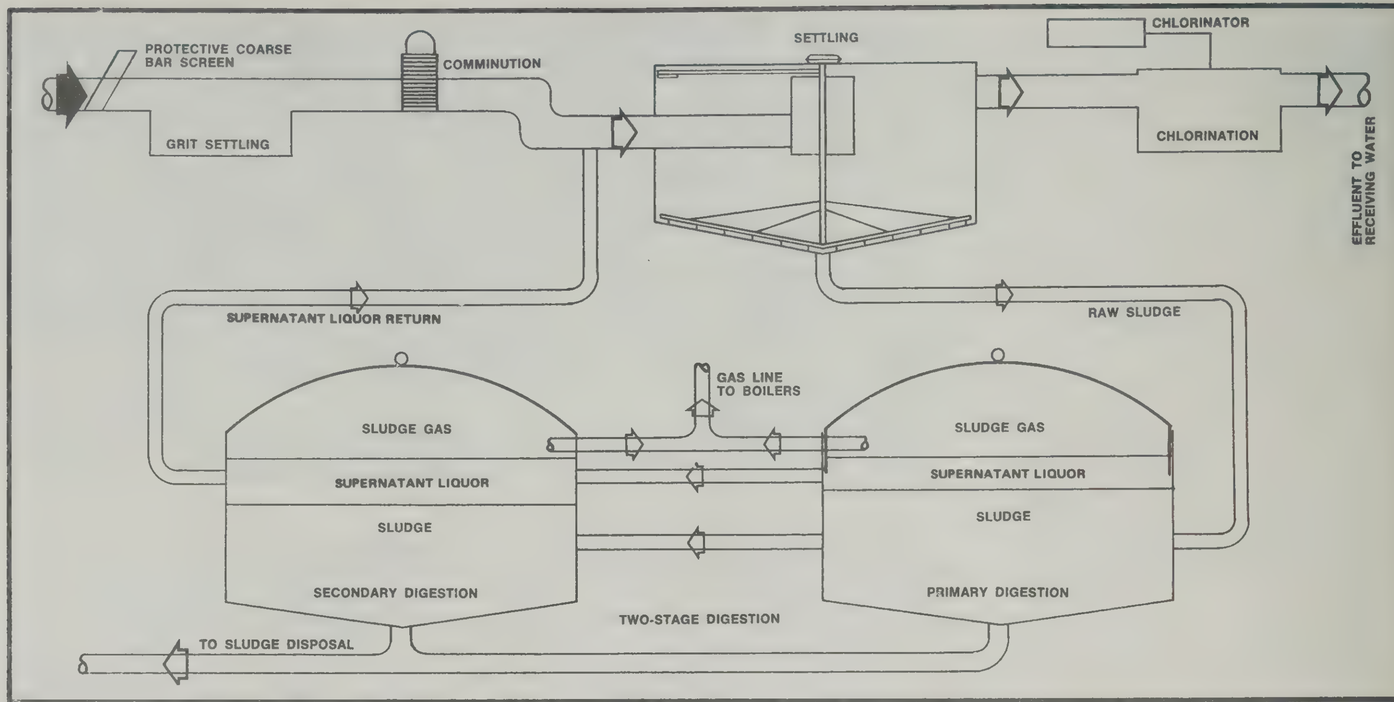
Secondary clarifier. Bridge mechanism supports drive for sludge scrapers in bottom of tank.



Chlorine retention tank.

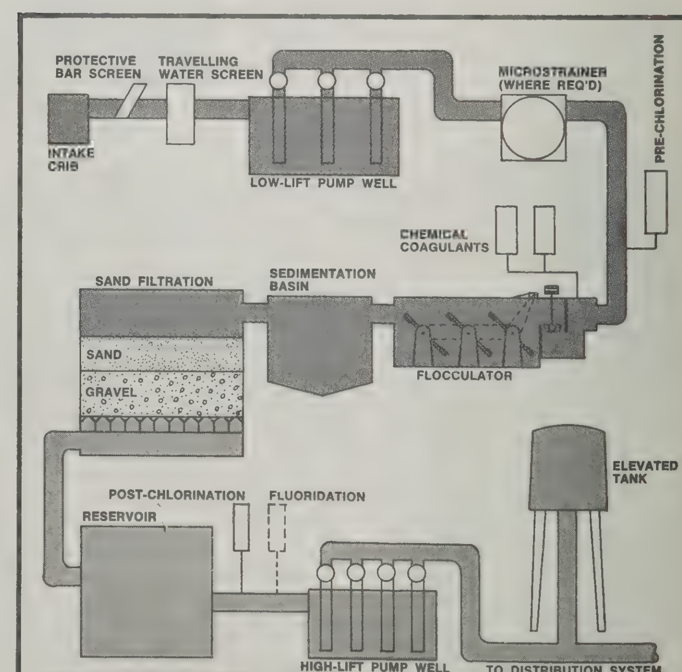
Sludge pump and heater, sludge-gas meters.

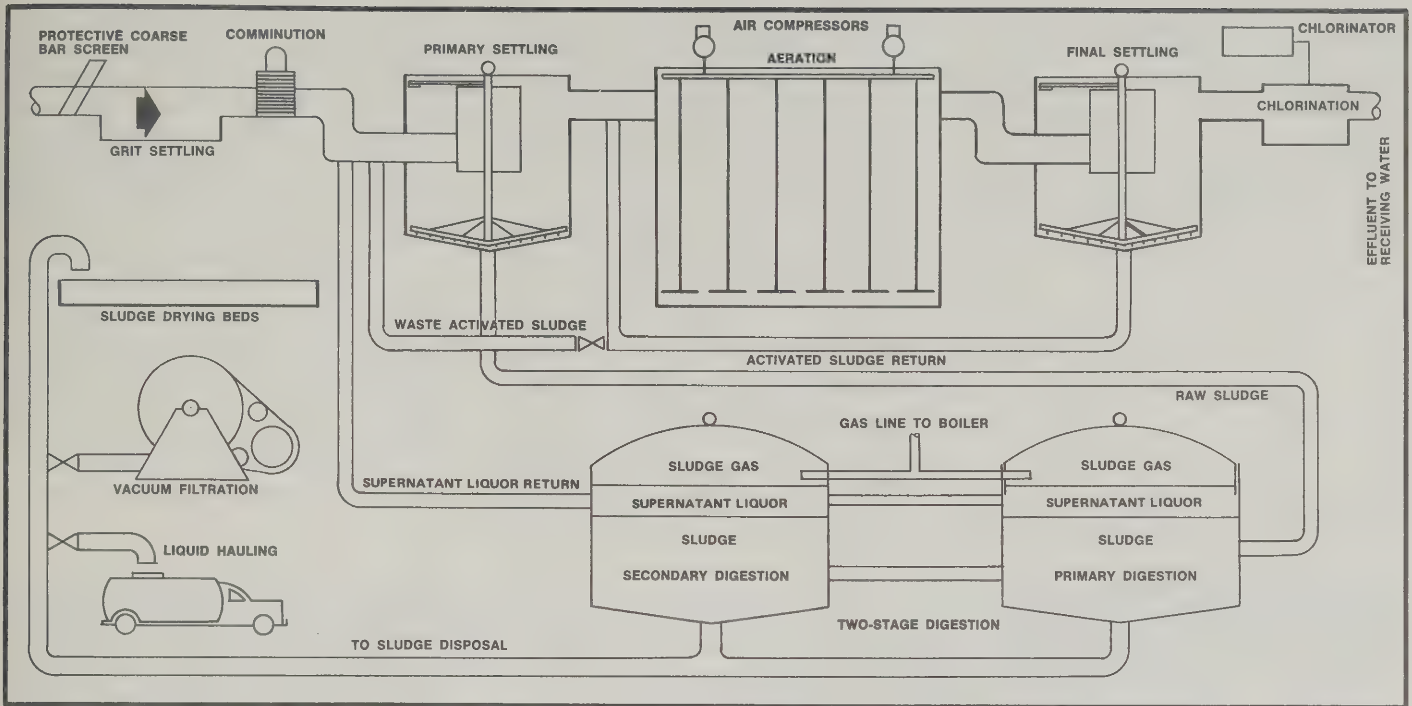
Above: sludge digestion tanks. Below: sludge drying beds. In background, right, sludge digester under insulating mound of earth and, left, secondary clarifier tank.



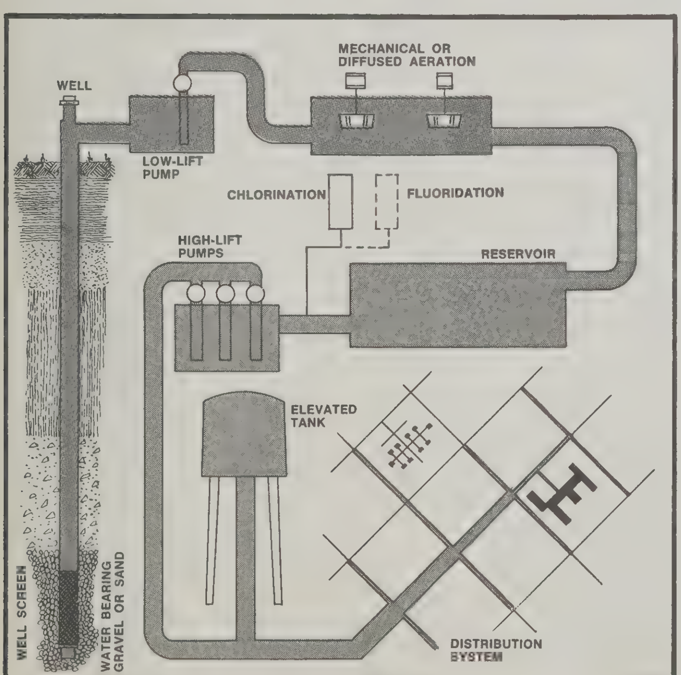
POLLUTION CONTROL, PRIMARY TREATMENT. Raw wastes are first passed through protective coarse screens to remove large material. This is followed by grit settling where inorganic matter is precipitated out before the wastes are passed through a comminutor that shreds the remaining solids. Primary settling is next where organic solids are collected and piped to the primary digestion tank. Liquid wastes drawn from the top of the tank are chlorinated before discharge to the receiving water. Sludge collected in the digesters is held in a closed environment where anaerobic bacteria oxidize it. Supernatant liquor drawn from each digester is piped back to the plant influent; sludge gas generated by the digestion process is either flared off or used to produce heat. Fully digested sludge is piped away for disposal.

WATER SUPPLY - SURFACE WATER SOURCE. Raw water drawn from a surface supply is first passed through a protective bar screen to remove large objects and debris. Next, a travelling screen removes smaller solid objects before low-lift pumps raise the water to the treatment plant. Should water conditions demand it, a microstrainer is employed to remove algae and large particulate matter. Following pre-chlorination, chemical coagulants are added and the water is passed through a flocculation tank where gentle mixing takes place prior to settlement in a sedimentation basin. Any finely suspended matter still remaining in the water is then removed in the filter bed, from which the water is passed to a reservoir. Finally, following post-chlorination (and fluoridation in some cases), the now treated water is pumped to an elevated tank and into the distribution system.





POLLUTION CONTROL, SECONDARY TREATMENT - ACTIVATED-SLUDGE PROCESS. Raw wastes are first passed through protective coarse screens to remove large material. This is followed by grit settling where inorganic matter is precipitated out before the wastes are passed through a comminutor that shreds the remaining solids. Primary settling is next where organic solids are collected and piped as raw sludge to the primary digestion tank. Liquid wastes drawn from the top of the primary settling tank are passed to the aeration tank where micro-organisms, promoted by air pumped into the tank contents, oxidize the organic fraction of the waste. This oxidized waste is then held for a brief period in a final settling tank - the sludge thus settling being termed activated sludge, which is pumped back to the inlet of the aeration tank. Clarified liquid decanting from the settling tank is chlorinated before discharge. Sludge collected in the digesters is held in a closed environment where anaerobic bacteria further oxidizes it. Supernatant liquor drawn from each digester is piped back to the inlet of the primary settling tank; sludge-gas, generated by the digestion process, is either flared off or used to produce heat. Fully digested sludge is piped away for disposal.



WATER SUPPLY - GROUND WATER SOURCE. Raw water is obtained from a water-bearing strata - usually sand or gravel - and drawn into the well through a screen to prevent clogging of the shaft by particulate matter. Low-lift pumps draw the water to the surface where, should conditions warrant it, it may be aerated or chemically treated before being passed to a storage reservoir. Following chlorination (and possibly fluoridation), high-lift pumps transfer the water, as required, either directly into the distribution system or to a high level storage tank ready for distribution.

The watery waste of industry

Ontario is the most industrialized of Canada's provinces. Along with this achievement has come the problem of industrial wastes - and, in particular, the problem of waste waters produced by our industrial community.

Unlike domestic pollution, which is organic in nature and susceptible to biological treatment, many industrial wastes have proved difficult to treat. Such wastes are particularly toxic to the receiving waters and may substantially harm the ecological balance of a river or lake. Wastes produced by the plating industry, the steel industry and many mining operations do not lend themselves to biological processes - although they can be so treated provided very close control is maintained over the condition of the waste and the particular plant process being used.

Through its Division of Industrial Wastes, the OWRC maintains a constant watch over the level of industrial pollution throughout the province. By discussing the problem with manufacturers and processors; by assisting in the solution to difficult waste treatment situations, the Commission has done much to relieve the industrial pollution load on our waterways. Through negotiation, many hundreds of Ontario industries have installed waste treatment facilities to bring their liquid discharges within the water quality objectives established by the OWRC.

Industrial waste pre-treatment works at a municipal sewage treatment plant.

The Ontario Water Resources Commission is truly the guardian of the Province's waterways. One segment of our society that makes full use of the thousands of miles of inland waters that make our province so attractive is the community of summer boaters. Even here, the Commission exercises its franchise to protect the quality of the waters and administers regulations that prohibits pleasure craft from discharging wastes overboard.

Canada is fortunate in the abundance of fresh water with which she is endowed - almost 25% of the world's total available supply. Ontario is bounded along several thousand miles of her boundary by the shores of many of the Great Lakes. This vast quantity of fresh water is a responsibility not taken lightly by the Ontario Water Resources Commission who are charged with the maintenance and protection of the quality of all the province's waters.

Water is a staple of life; without water there would be no life. Like any other commodity, water can be damaged beyond repair - and the uncontrolled pollution of Ontario's waters would create such damage.

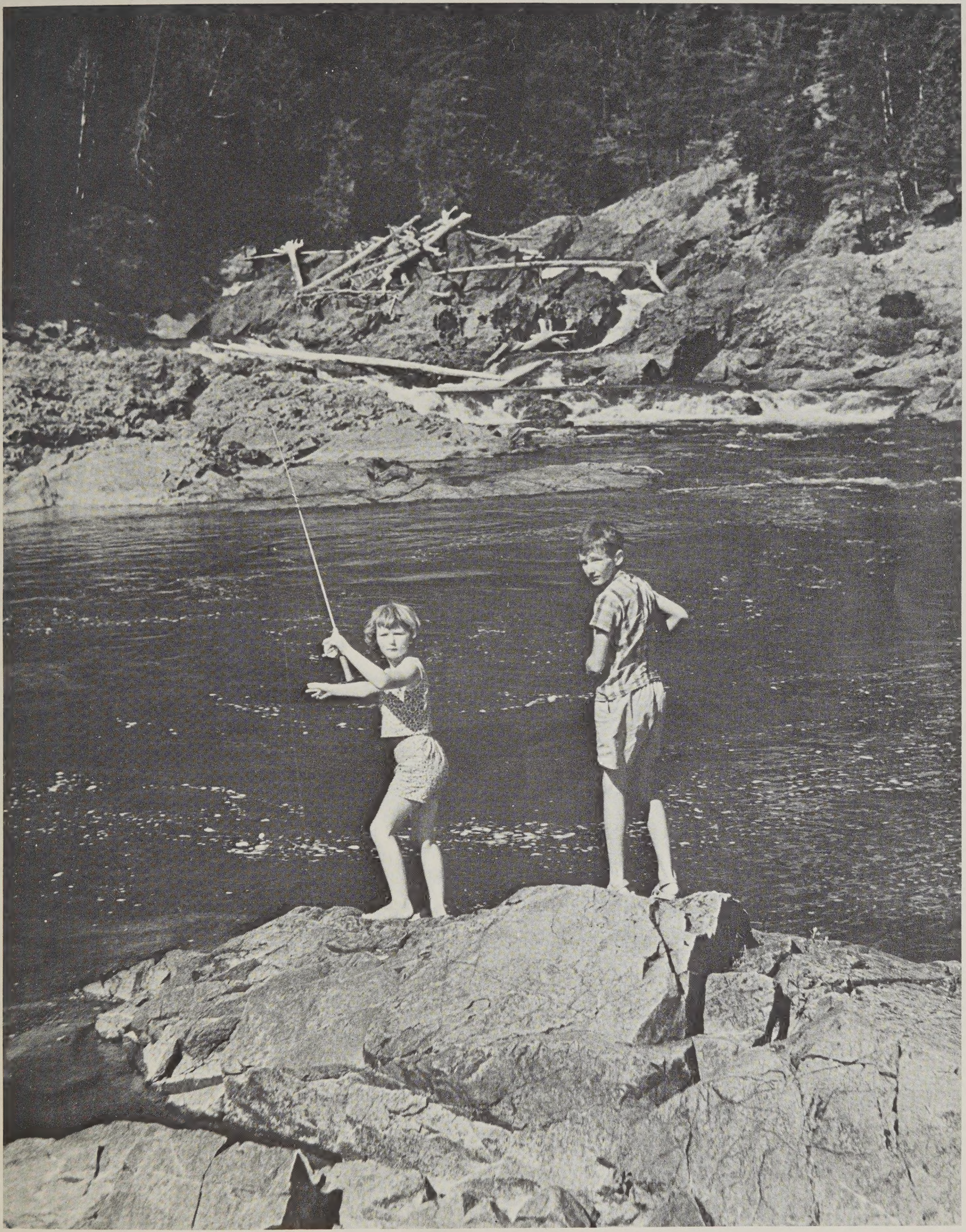
Through the co-operation of the citizens of the province, the Commission has been able to achieve much in the preservation of our water. Continued co-operation will ensure that they remain safe.

The water of our waterways

Water terminology

As with all sciences, hydrology has a language all its own. Many of the terms used in the study of water have no relevance to any other subject - some, even, mean quite different things when used by scientists of other disciplines. Here is a list of some terms used during water studies, together with a brief definition of each.

Acidity Ordinarily expressed as a pH below 7.
Algae An assemblage of non-vascular plants consisting of a great number of genera and species, both microscopic and large in size. Algae carry on photosynthesis which differentiates them from fungi.
Algicide Any substance which kills algae.
Alkalinity Ordinarily expressed as a pH above 7.
Aquamarsh A stage in the evolution between open water and land marsh.
Aquatic plants The aquatic plants of lakes and other kinds of standing water bodies are those whose seeds germinate in the water or in the lake-bottom soil.
Aquifer A layer of rock, sand or gravel through which water can pass.
Artesian Describes underground water trapped under pressure between layers of impermeable rock. An artesian well is one that taps artesian water.
Bacteria One-celled micro-organisms.
Bank Pertaining to a lake, the sharply rising ground, or abrupt slope, usually wave-cut and presenting a nearly vertical front.
Basin An impoundment.
Beach The width of the shore zone lapped by waves.
Bed Submerged land surface of a lake basin.
Benthos A limnological term for a whole group of bottom dwelling organisms of a lake.
Biochemical oxygen demand The amount of dissolved oxygen in parts per million, required by organisms and for the aerobic biochemical decomposition of organic matter present in water.
Bog Any wetland feature or body of land, characterized by a spongy, miry surface.
Breakwater A structure for breaking the force of waves.
Canal A dredged canal connecting two bodies of water.
Cape A rounded projection out into the water.
Capillarity The force that causes water to rise in a constricted space through molecular attraction, often against the pull of gravity.
Cat ice Ice forming a thin shell from under which the water has receded.
Catchment basin The entire area from which drainage is received.
Causeway A raised way or road made across wet or marshy ground, or across the surface of a lake.
Cesspool Structure designed to hold sewage from a residence.
Chemical oxygen demand Total oxygen consumed by the chemical oxidation of material in water.
Coast Shorelands of the Great Lakes, or land bordering seas.
Coliform bacteria The 'coli aerogenes' group. A test for the presence of coliform bacteria is commonly used to determine the presence of fecal coli from sewage.
Condensation The transformation of water from a vapour to a liquid.
Cone of depression A conical dimple in the water table surrounding a well, caused by pumping.
Consumptive use The use of water, especially in irrigation, in such a way that it is converted to vapour and returned to the atmosphere.
Cooling water Water that has been used primarily for cooling in an industrial or manufacturing process.
Currents Movements or flows of the water.
Dam A structure designed to hold back a flow of water.
Dam lake One created by a dam.
Dam pond An impoundment behind a man-made dam.
Dead lake Colloquialism for lakes that have become filled with vegetation.
Deadhead A log lying on the bottom of a lake, or in the bed of a river.
Deadwater A stream of water that appears to have no flow.
Depth Thickness of the water - generally implies the whole vertical distance between the surface and the bottom at a given position.
Desalination Process of removing salt from water.
Desiccation Loss of water by direct evaporation.
Destratification Artificial circulation or mixing of the water.
Diatoms Microscopic plants which occur abundantly as floating forms in plankton.
Dike Artificial embankment.
Discharge The rate of flow of surface or underground water.
Disposal area Area of land, usually in a marsh or swamp, where dredged material from a lake improvement project is deposited.
Dissolved oxygen The amount of dissolved oxygen in parts per million present in water.
Diversion Draining, pumping, siphoning or removal of water from a lake in any manner that is not natural.
Drag line Machine sometimes used to remove bottom material from a lake.
Drain A surface ditch or underground pipe for the purpose of conducting fluids.
Drainage basin The geographical area within which all surface water tends to flow into a single river or stream via its tributaries.
Drawdown Term for a decrease in the levels of reservoirs or other impoundments.
Drift Speed of a current.
Drop-off Scarp or bank of a sub-aqueous terrace or littoral shelf.
Effluent An outflowing surface stream.
Enriched lake One that has received inputs of nitrates, phosphates and other nutrients, thereby greatly increasing the growth potential for algae and other aquatic plants.
Ephemeral lakes Short lived lakes and ponds.
Epilimnion In a thermally stratified lake, the turbulent layer of water that extends from the surface to the thermocline.
Erosion The wearing down of the earth's surface by water.
Euphotic zone Depth zone through which light penetrates water. Effective in photosynthesis.
Eutrophic lakes 'Rich' lakes; those well provided with the basic nutrients required for plant and animal production.
Evaporation Transformation of water into vapour.
Evapotranspiration The process by which water, evaporated from the earth and given off by plants and animals, is returned to the atmosphere as vapour.
False beach A bar, above water level, a short distance off shore.
Farm pond A small shallow structure for the impoundment of water.
Fast ice Ice attached to, and extending out from the land.
Fault A break in the earth's crust.
Fecal Matter Human and animal excrement.
Fetch On a lake surface, the reach, or longest distance over which the wind can sweep unobstructed.
Finger lakes Long, narrow lakes occupying deep troughs in deeply eroded, straight pre-glacial valleys in glaciated regions.
Fish kill Destruction of fish in lakes or ponds due to prolonged ice and snow cover resulting in oxygen deficiency.
Fission lakes Lakes which represent division of, or separation from, an original single body of water.
Floodplain A strip of flat land bordering a stream or river consisting of sediment laid down over the centuries by the river.
Flooding Water bodies which inundate or cover flat lands as a thin sheet.
Flowage Volume or dimensions of the water of a stream.
Flushing period Time required for an amount of water equal to the volume of the lake to pass through its outlet.
Fluviatile lake Lake formed in the flood plain of a river such as an ox-bow lake, or other water body formed as a result of stream erosion and deposition.
Forebay Small pond, or reservoir, at the head of the penstock of a power dam.
Foreshore Part of a shore, or beach, normally subject to the uprush and backrush of waves.
Fossil lake One that has been extinct for a long period of time.
Freshet Small affluent streams having a high rate of flow.
Gabion Specially designed basket or box of corrosion resistant wire designed to hold rocks to form groins, sea walls, etc.
Glacial lakes Lakes formed as a result of glacial action.
Groin Long, narrow wall-like structure extending out into a lake normal to the shore.
Groundwater All subsurface water.
Headrace A race constructed to lead water to a water wheel or into an industrial building.
Headwater Beginning of a stream or river, its source.
Hydrograph A graph showing the stages, or variations in water level over a period of time.
Hydrographic basin Area of the watershed of a lake plus the area of the lake.
Hydrologic cycle The process by which water constantly circulates from the sea to the atmosphere to the earth, and back to the sea again.
Hydrology The scientific study of water found on the earth's surface, in its subsurfaces, and in the atmosphere.
Hydrolysis The process by which a compound reacts chemically with water and forms a new substance.
Hypolimnion The water below the thermocline.
Influent An in-flowing stream.
Infiltration The method by which surface water is soaked into the ground through tiny openings in the soil.
Island An area of land within a lake.
Jetty Structure similar to a groin.
Lagoon Water body in depression.
Leaching Process by which water, seeping through earth and rocks, dissolves and carries away certain minerals or compounds.
Limnetic zone In lakes partly occupied by emergent vegetation, the area of open water.
Limnology Science which deals with lakes, and by extension with all inland waters. It is concerned especially with the biology of the waters and bottoms.
Margin Land immediately bordering the water line.
Mesotrophic lake One that is intermediate in fertility; neither notably high nor notably low in its total productivity. Intermediate between oligotrophic and eutrophic.
MPN Most probable number (of coliform bacteria), one of the standard laboratory tests.
Narrows Constriction in the width of a lake.
O.D. Abbreviation for oxygen demand.
Outfall Term used for the end of a pipe, ditch, drain, or distributor that carries an effluent into a lake or stream.
Oxbow A curved lake, created when a bend is abandoned by a river that has changed its course.
Pathogenic bacteria Bacteria which cause disease.
Penstock Closed tube used to conduct water under pressure from a reservoir to a turbine house.
Permeability Capacity of a solid to allow the passage of a liquid.
Piezometric surface The theoretical level to which water should rise under its own pressure if tapped by well or spring.
Piling Usually wooden posts driven into the lake bottom to support docks or other structures.
Plankton A term for an assemblage of micro-organisms, both plant and animal, which float, drift or swim in the water.
Pollution Destruction of the purity of water by impairing its quality to a point where it becomes unfit for the many uses for which it is required.
Pond The term pond is generally applied to small impoundments for a source of water for livestock and for other uses on farms. However, the term can be used for large impoundments of water.
Porosity The ability of rock and other earth materials to hold water in open spaces or pores.
Potable water Water suitable for drinking water. Generally untreated lake water is not potable water.
P.P.B. Abbreviation for parts per billion.
P.P.M. Abbreviation for parts per million.
Precipitation The discharge of condensed water vapour by the atmosphere in the form of rain, hail, sleet or snow.
Putrescible waste Matter, usually of animal origin, that is subject to the process of putrefaction.
Race An artificial channel, or canal leading from a dam to a water wheel, or other contrivance for generating power.
Reef A shoal consisting of a ridge of sand, gravel or hard rock.
Reservoir Applied to waters held in storage in either artificial or natural basins.
Revetment A facing of stone, concrete or other material to protect the banks of a lake from wave erosion.
Rich lakes A term applied to those "rich" in nutrients and capable of supporting an abundant flora and fauna.
Riparian A person with rights to water by virtue of ownership of land bordering the bank of a stream or waterline of a lake.
Ripple A very small wave: one whose period is arbitrarily defined as three seconds or less.
Riprap Coarse stones, natural boulders or rock fragments laid against the basal slope of a bank for the prevention of wave cutting.
Rough fish Those species such as carp and sucker, considered undesirable, predatory or obnoxious by anglers.
Satellite lakes One or more small lakes disconnected and separated from but associated with a single large lake in a single basin.
Scour Lakes occupying depressions, or basins, made by gouging and abrading actions of glaciers passing over soft rocks or moving in pre-existing valleys.
Sediment Tiny particles of rock and dirt carried by water, which eventually settle to the bottom.
Seepage lake One that loses water mainly by seepage through the walls and floor of its basin.
Senescent lake One nearing extinction; especially from filling by the remains of aquatic vegetation.
Settling basin An artificial basin for collecting the sediment of a river before it flows into a reservoir.
Sewage An inclusive term applied to all effluent carried by a sewerage system.
Shore Technically the zone of wave action on land.
Silting The filling of reservoirs by sediments.
Skim ice When freezing first commences on a lake the first ice crystals formed are free floating or weakly attached.
Skin ice The first film or crust of newly formed ice.
Slime Soft fine oozy mud.
Slough Standing water bodies.
Sludge Term used to define settled waste material (in liquid or solid form) in sewage treatment plants.
Sludge drying bed Used to dewater pretreated sludge and reduce volume to be handled for disposal.
Snag lake A lake containing trunks and branches of trees, or the pointed roots of stumps lying on the bottom.
Spring An opening in the surface of the earth from which groundwater flows.
Stocked lake A lake which has been planted with fish of a desirable species.
Storage reservoir In a storage reservoir water is impounded back of a high dam and held for later use.
Strand The strip at the base of shore cliff, or along shore, that is lapped by waves.
Stratified flow When a difference exists between the density of the inflowing water and that of a lake or reservoir.
Stratified lakes In deeper lakes, especially in temperate regions, the water from top to bottom exhibits differences in temperatures.
Subaquatic plants Emergent plants; or hydrophytes which are not submersed.
Surf The effect produced by the break of a wave as it enters shallow water or a shallow shore zone.
Surface waters That lying on the surface of the land in contrast to underground water.
Swell A wave that continues after the wind has ceased.
Swimmers itch A rash produced by a parasitic flat worm (in the cercarial stage of its life) which penetrates the skin of bathers.
Tailing ponds Enclosures, or basins, constructed for the disposal of mine tailings.
Terrace A plateau on the side of a valley, representing an old floodplain no longer reached by the river below.
Thermocline In thermally stratified lakes, the layer below the epilimnion.
Transpiration losses Water consumed by emergent and floating lake plants, voided as gas through specialized leaf cells.
Turbidity Cloudiness caused by sediment suspended in water.
Underflow The downstream movement of groundwater through permeable rock beneath a riverbed.
Virus An extremely small living organism or non-living particle; it is sometimes found in lake water.
Wake The track left in the water by a moving boat.
Waste stabilization pond A shallow artificial pond constructed for the stabilization of municipal and industrial wastes.
Water bloom A prolific growth of plankton.
Water quality The graded value of a single property, or the characteristics as a whole, in relation to a particular use.
Waterline The line of contact between the still water of a lake or pond and the bordering land.
Watershed The whole surface drainage area that contributes water to a lake.
Water table The level to which groundwater rises, or the surface of the zone of saturation.
Waterway A navigable body of water, natural or artificial, which serves as a water highway or water road.
Wave A wave is an undulation or ridge on a water surface.
Wild rice An aquatic grass, fairly common in northern lakes.
Yield The quantity of water which can be taken, continuously, for any particular economic use.
Zooplankton Animal micro-organisms living unattached in the water.



Water management in Ontario

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